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# STRATEGIES ADOPTED BY RAINFED FARMS FOR SUSTAINABILITY IN TAMIL NADU

**VIDHYAVATHI. A**

*Associate Professor, Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India*

***ABSTRACT***

***India ranks first among the rainfed countries in the entire world with nearly 58 percent of the cultivated area under rainfed agriculture, which meets out 40 percent of the world's food production. Nearly 41 percent (2.83 Million ha) of the net cultivated area was under rainfed condition in Tamil Nadu (2015-16). In India, the yield levels of crops were low when compared to other developed countries in the world, is the reason being low adoption of recommended technologies in India. With no further scope of increasing the area under cultivation and irrigation sources, high productivity can only be achieved by increasing the rate of technology adoption. With this in focus, the present study is an attempt to measure the efficiency and the level of technology adoption in rainfed farms. Sustainability yield index calculated for 5 major rainfed crops in the district indicated, that the yield of horse gram was more sustainable for the past five years. Farmers adopt drought tolerant variety and summer ploughing as major rainfed coping strategies in all the crops. Attempts to examine the rate of adoption of recommended rainfed technologies by CRIDA revealed that there is still a scope for increasing the income through adopting several rainfed technologies and strategies.***

***KEYWORDS: Rainfed Farms, Sustainability, Coping Strategies, Adoption & Technology***

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## INTRODUCTION

Rainfed agriculture is a form of agriculture that is entirely dependent on rainwater for irrigation. Areas that receive more than 750 mm rainwater a year are classified as rainfed areas. Rainfed agriculture produces the large amount of foods that were consumed by the poor communities in developing countries. It accounts for more than 95% of farmed land in sub-Saharan Africa; 90% in Latin America; 75% in the Near East and North Africa; 65% in East Asia; and 60% in South Asia (IWMI, 2010). Further, about 70 percent of the world's staple food continues and will continue to be harvested from rainfed areas, since the scope for further expansion of irrigation is limited due to growing competition for water and the high investment cost (Sharma, 2011).

India ranks first among the rainfed countries in the entire world with nearly 58 percent of the cultivated area under rainfed agriculture meeting out 40 percent of the country's food production and it is critical to achieve and sustain higher growth in agriculture. Even after the full irrigation potential of the country is realized, half of the cultivated area will continue to be under rainfed farming (CRIDA, 1997). Tamil Nadu is one of the water starved states in India and is endowed with only 3 percent of water resources in India (State Agricultural Profile of TN-2011). Rainfed area in Tamil Nadu is around 28 lakh hectares (45.2 percent) in the year 2015-16.

The present study is a modest attempt to assess the farm efficiency, extent of technology adoption by rainfed farmers and to bring out the reasons for non-adoption of recommended rainfed technologies. The main

objectives of the study are to estimate the cost of cultivation and efficiencies of major rainfed crops; in order to examine the level of technology adoption in rainfed crops and assess the coping strategies followed in rainfed farms.

## MATERIALS AND METHODS

Multi stage random sampling was done to select the study area. From 7 agro climatic zones of Tamil Nadu, North western zone had a highest percent of rainfed area of 566795 ha (27.65 percent of total rainfed area). From the North western zone, Dharmapuri and Krishnagiri districts were chosen for the present study. From the Dharmapuri district, two blocks namely Pennagaram ad harur and in Krishnagiri district, two blocks Thally and Kelamangalam were chosen, based on their highest area under rainfed cultivation. Fifteen rainfed farmers were randomly selected from each block and surveyed making the total sample size to sixty. In order to fulfill the objective of the study, necessary primary data were collected from sample respondents through a personal interview method, using pre-tested and well structured interview schedule. Secondary data such as area, production and productivity of rainfed crops were collected from various sources like Seasons, Crop Report of Tamil Nadu and Reports of Agricultural office. The data pertains to the agricultural year 2017-18. The tools and techniques employed are as follows:

**Sustainability Index**

- Singh *et al.,* (1990) Sustainability Index (SI)

$$SI = \frac{Y_{bar} - s}{Y_{max}}$$

where, $Y_{bar}$ is the average yield of a treatment; s is the standard deviation of yields over the years and $Y_{max}$ is the maximum yield of a treatment in any year. Higher the value of the index, higher is the sustainability status.

- Sahu et al. (2005) Sustainability Index (SI)

$$SI = \frac{Ymax - Ybar}{Y\,bar}$$

A sustainability index value that closer to zero is the most desirable value. This index was worked out for major crops cultivated under rainfed farms namely ragi, red gram, horse gram, groundnut and sorghum.

**Resource Use Efficiency**

Cobb Douglas production function was used for the estimation of resource use efficiency of ragi crop, being the major crop in the rainfed farms. It can be expressed as

$$\textbf{Log } y = \log a + b_1 \log x_1 + b_2 \log x_2 \ldots\ldots\ldots + b_6 \log x_6 + \mu$$

where: y - Yield (Kg/ha)

a- Constant or intercept value

$x_1$- Seeds(kg/ha)

$x_2$ - Human labour (Man days/ha)

$x_3$- Bullock and Machine labour ( /ha)

$x_4$- Farm yard Manure (in tons/ha)

$x_5$ -Nitrogen (kg/ha)

$x_6$ -Phosphorus(kg/ha)

$b_1$ to $b_6$ - regression coefficients of independent variables ($x_1$ to $x_6$) and μ is the error term.

**Adoption Index**

To quantify the adoption of technologies the following adoption Index were constructed by Suseela et al., 2018 was used:

$$AI = \frac{a}{p} \times 100$$

Where,

a- Number of practices adopted by respondents

p- Number of practices selected

## RESULTS AND DISCUSSIONS

**Sustainability Index**

Based on the five years yield data (2013-2018) collected for five major rainfed crops (Ragi, Red gram, Groundnut, Horse gram and Sorghum) sustainability yield index was calculated. It is evident from Table I, that the sustainability yield index value was highest for Horse gram followed by Red gram. This means that Horse gram yield was more sustainable than the yield of other crops because of its ability to thrive in adverse conditions.

**Socio-Economic Characteristics of Farm Households**

Socio-economic characteristics of farm households are presented in Table II. Out of 60 farmers, 60 percent were between 34-59 years of age group category. About 47 percent of the farmers had completed high school and 20 percent were illiterate. Majority of the farmers (80 percent) were having nuclear size family. 90 percent of the surveyed farmers were marginal farmers having an average farm size of 0.97 ha followed by small farmers with an average farm size of 2.8 ha. The average size of medium farms was 5.20 ha. About 87 percent of the farmers were having experience in farming between 7-32 years.

**Cropping Pattern of the Sample Farms**

The cropping pattern of the sample farms indicated that the total area of farms 51 percent was occupied by Ragi crop followed by groundnut (23.81 percent), red gram (20.11 percent), horse gram (2.12 percent) and little millet (2.12 percent), since, seeds of ragi, red gram and groundnut were available at subsidized price to the farmers under the scheme “Mission on Sustainable Dry Land Agriculture”

**Crop Varieties Cultivated in the Sample Farms**

Most of the farmers were cultivating the drought tolerant varieties that were released from GKVK University, Bangalore. The varieties that were cultivated by the sample farmers includes ML 365, GPU 48, GPU 28, L5, L7 of ragi, BRG 1,BRG

2 varieties of red gram, ICGV 350 variety of groundnut and Paiyur 2 variety of horse gram. Few farms in the survey area were found to be seed producing farms to the University and they were earning more profit than the normal rainfed farms. The sample farmers purchased seeds from Agricultural department or fertilizer shops or University or from nearby farmers.

**Livestock Possession of the Sample Farms**

Majority of the surveyed small and marginal farmers owned Jersey cow and those are providing the source of livelihood to the farmers during off season. Only few farmers were having country cow, the reason behind is, its low milk yield. Each farm had minimum one number of Jersey cow and to a maximum of two. Very few farms were rearing goats. Average value of Jersey cow in that region was  30,000 and that of Country cow was  60,000 and Goat was  3975.

**Distribution of Households on the basis of Annual Income**

The annual non farm income ( 201731) was higher than that of on-farm ( 172231) and off-farm income was  63330/year. Average annual income (43 percent) of the farmers was ranged between one lakh to two lakh and the average annual income of the sample farmers was 145764. The major non-farm income source in that region was salary from IT companies.

**Employment Pattern of the Sample Households**

The farmers were engaged for about 228 days (most of the working days were spent on livestock rearing) and on an average 90 days in off-farm activities and 240 days in non-farm activities. Land was cultivated only for 3 months in a year. Some of the marginal farmers worked as agricultural labours in green houses during off season and they were paid low wage (100/day).

**Descriptive Statistics**

The descriptive statistics provides the minimum, maximum, mean and standard deviation of the various variables used in the production function. The recommended dosage for seeds and fertilizers are 15-20kg/ha and 40:20:20 N:P:K kg/ha. The results are presented in Table III. Here, the sample farmers used higher quantity of seed, nitrogen and phosphorus than the recommended dosage whereas potassium was not applied by the rainfed farmers.

**Resource Use Efficiency of Rainfed Ragi**

The results of the resource use efficiency are presented in Table IV. The co-efficient of multiple determinations ($R^2$) for rainfed ragi cultivation was 0.86 indicating that the variables included in the production function were about 86 percent of the variation in the production.

The regression co-efficient of Nitrogen (0.4285) and Phosphorus (0.3668) were found to be statistically significant at one percent and five percent respectively. Whereas, the regression coefficients of seed (-0.8491), human labour (-1.2281), bullock and machine labour cost (-0.2817) and Farm yard manure (0.1457) were non-significant. One unit increase in the input use of Nitrogen and Phosphorus above its geometric mean level will leads to 0.4285 and 0.3668 percent increase in yield from its geometric mean level.

**Crop-wise Frequency distribution of Sample Respondents adopting Rainfed Technology**

Summer ploughing was adopted by almost all the sample farmers and it was done ten days before the onset of monsoon, since, it increases the water infiltration rate in the soil. In case of ragi, the adoption of drought tolerant variety was highest

(90 percent) since it was available at subsidized rates to the farmers followed by Soil testing and Intercropping (40 per cent each) and soil and water conservation measures (5 per cent). Soil samples collected from the farmers' fields were sent to soil testing laboratory in the district and recommendations regarding the choice of crops were given to the farmers. Intercrops that were mainly include lablab (Avarai), mustard and fodder sorghum in 4:1 ratio with the main crop. Some of the farmers mix all the above intercrop and sow in a single row. Seed treatment using azospirillum was rarely done by sample farmers (15 per cent), no soil and water conservation measures were done except summer ploughing (5 percent).

In case of Red gram, adoption of drought tolerant varieties (BRG 1, BRG2) was highest (83.33 percent) followed by seed treatment (66.67 percent) which was done with rhizobium, azospirillum and intercropping was adopted by 66.67 percent of red gram farmers. Intercropping in red gram was done with Lablab (Avarai), Ragi, Groundnut. Soil and water conservation measures were adopted by 33.33 percent each. Whereas, the foliar spray and sowing with machinery were adopted by 16.67 percent of the farmers each. Foliar spray was mainly done with DAP and machines that were used for harvesting. In case of groundnut, there was high adoption rate of drought tolerant variety (100 percent) followed by foliar spray (71.43 percent) which is done with 2 percent of DAP to induce flowering. Soil and water conservation measures, gypsum application and earthing-up operations were adopted by 42.86 percent of sample farmers each. Whereas, seed treatment and intercropping were adopted by 28.57 percent of the farmers and Sowing by machinery was adopted among 14.29 percent of the sample farmers. Sowing with machinery was found to be very low because farmers found it to be a costlier method.

**Extent of Adoption of Technology in Rainfed Farms**

Level of adoption of technology in rainfed farms were analyzed through technology adoption index (TAI) and the results presented in the Table V. The TAI for each farmer was computed by dividing the number of practices adopted by respondents with the total number of practices selected and expressed as percentage. Farmers were categorized into five categories viz., non-adopters (0), low adopters (1-25), medium adopters (25-50), high adopters (50-75) and very high adopters (75-100) on the basis of their level of adoption measured in terms of TAI. Most of the surveyed farmers come into the medium adopter category. In Ragi, the number of farmers in the medium adopters category was highest with the mean adoption index of 40 percent followed by high and low adopter category with a mean adoption index of 60 and 20 percent respectively. The non-adopters accounted for 5 percent. In Red gram, medium adopters shared the highest percent with mean adoption rate of 37 percent followed by high adopters with a mean adoption rate of 67 percent. In Groundnut, medium adopters were highest with the mean adoption rate of 36 percent followed by high adopters with an adoption rate of 61.7 percent.

**Strategies of Sustainable Crop Production in Rainfed Region**

The details of major rainfed coping mechanisms suggested by CRIDA, their extent of adoption and the problems encountered in their adoption is given in the Table VI.

**Water Management Practices**

To conserve water in the rainfed lands, several water management practices such as construction of farm ponds, summer ploughing, bunding and terracing, vegetative barriers, formation of ridges and furrows, opening of dead furrows can be followed. In the surveyed areas, summer ploughing was done ten days before receiving the rain. The major reason for not adopting the above management practices includes lack of finance, labour shortage, higher cost, lack of knowledge and

inadequate rainfall

**Nutrient Management Practices**

Nutrient management practices adopted by the farmers include mulching which was done with crop residues, crop rotation with legumes since, the legume crops have the ability to fix atmospheric nitrogen which can be used by the main crop, addition of farm yard manure, seed treatment with bio-fertilizers like rhizobium and azospirillum, Integrated Nutrient management and foliar spray which are mainly done in red gram to induce flowering. The problem involved in adopting these practices is mainly due to lack of resources, lack of finance and some farmers even do not have any knowledge of these practices.

**Mechanization-** was regarded as costlier method by the rainfed farmers as they are resource poor and it is dearth of capital to have huge investments and which is mainly done in Groundnut fields for harvesting.

**Income diversification**- a very good option to get an income throughout the year. Rainfed farmers cultivate their land only when they receive rain ie., Month of September. Some farmers do livestock rearing and some others work as agricultural labours in the nearby Green houses to get an income during the off season.

**Crop and Cattle insurance**- Majority of the farmers had no faith in insurance policies as the government did not provide money even in case of any damage.

**Formal marketing**- Most of the surveyed farmers sell their products to the traders at very low prices from their farm gates, because the transportation cost involved in transporting the products to the market place is higher.

**Contingency crop plan** helps the farmers to take up various agricultural operations at appropriate times. But the problem involved is, farmers do not have any knowledge about this strategy.

**Cropping Systems**

Cropping systems like Intercropping, Agri-horti systems, Agro forestry systems, Fodder systems and Integrated farming system can be followed in this region. Among these systems, farmers follow intercropping of mainly legumes and mustard, integrated farming system which is mainly Crop-livestock systems. The reason for not adopting the other practices is lack of finance, fear of loss, labour shortage, inadequate rainfall and lack of marketing facilities.

To summarize, among the rainfed farmers, small and marginal farmers were most affected, because of monsoon failures and the technology adoption was also low among small and marginal farmers as they do not have adequate resources. The land was entirely dependent on rain water and was cultivated with crops such as groundnut, ragi and red gram either as mono crop or intercrop situations only for 3 months (July- September). It was left fallow for the remaining months. From the study, the suggestions like making formal credit facilities available to small and marginal farmers; ensuring the payment of insurance claims; providing weather based agro advisory services and encouraging the farmers to form unions at village level for collective marketing of the produce could make rainfed farms more sustainable in future.

**Table 1: Sustainability Yield Index of Major Rainfed Crops**

| Sl. No | Crops | Singh's Sustainability Index | Sahu's Sustainability Index |
|---|---|---|---|
| 1 | Ragi | 0.52 | 0.38 |
| 2 | Red gram | 0.58 | 0.35 |
| 3 | Horse gram | 0.63 | 0.30 |

| Table 1: Contd., | | | |
|---|---|---|---|
| 4 | Groundnut | 0.51 | 0.45 |
| 5 | Sorghum | 0.34 | 0.63 |

**Table 2: Socio-Economic Characteristics of Farm Households**

| Particulars | No. of Farmers/Holdings |
|---|---|
| **i. Age Group** | |
| ≤34 | 12 (20.00) |
| 34-59 | 36 (60.00) |
| ≥59 | 12 (20.00) |
| Average age (Years) | 46.8 |
| **ii. Education** | |
| Illiterate | 12 (20.00) |
| Primary | 8 (13.33) |
| High school | 28 (46.67) |
| College | 12 (20.00) |
| **iii. Family Size** | |
| Nuclear | 50 (83.33) |
| Joint | 10 (16.67) |
| **iv. Land Holdings** | |
| Marginal(<2ha) | 54 (90.00) |
| Small(2-4ha) | 4 (06.66) |
| Medium(4-6ha) | 2 (03.33) |
| Large(>6ha) | 0 |
| Average holding size(ha) | 1.39 |
| **v. Farming Experience (Years)** | |
| ≤7 | 4 (06.67) |
| 7-32 | 52 (86.67) |
| ≥32 | 8 (13.33) |

**Table 3: Descriptive Statistics of Variables used in Cobb- Douglas Production Function**

| S.No | Particulars | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|---|
| 1 | Yield (kg/ha) | 1500 | 3000 | 2303.788 | 410.172 |
| 2 | FYM (Tons/ha) | 0 | 8 | 3.455 | 2.770 |
| 3 | Human labour (No of mandays /ha)) | 48 | 70 | 56.364 | 7.500 |
| 4 | Bullock & machine labour cost (□/ha) | 6750 | 8700 | 7972.727 | 534.960 |
| 5 | Seeds (kg/ha) | 14 | 33 | 23.818 | 6.161 |
| 6 | Nitrogen(kg/ha) | 45 | 275 | 171.045 | 70.788 |
| 7 | Phosphorus(kg/ha) | 18 | 60 | 44.364 | 13.828 |

**Table 4: Resource Use Efficiency of Rainfed Ragi in Sample Districts**

| Variable | Coefficient Value | t value |
|---|---|---|
| Constant | 14.1829*** | 6.9795 |
| Seeds(kg/ha) | -0.8491 | -1.9578 |
| Human labour (man days/ha) | -1.2281 | -1.6472 |
| Bullock and machine labour cost(□/ha) | -0.2817 | -2.6262 |
| Farm yard manure(tons/ha) | 0.1457 | 1.6580 |

| Table 4: Contd., | | |
|---|---|---|
| Nitrogen(kg) | 0.4286*** | 4.8539 |
| Phosphorus(kg) | 0.3668** | 3.52132 |
| $R^2$ | 0.86 | |

***-significant at 1%, **- significant at 5%, *- significant at 10%

**Table 5: Extent of Adoption of Technologies in Rainfed Farms**

| Crop | | Ragi | | Red gram | | Groundnut | |
|---|---|---|---|---|---|---|---|
| Category (%) | Adoption Rate | No of Farmers | Mean Adoption Index(%) | No of Farmers | Adoption Index (%) | No of Farmers | Mean Adoption Index (%) |
| **0** | **Non Adopter** | 2 (5) | 0 | 0 | 0 | 0 | 0 |
| **01-25** | **Low** | 10 (25) | 20.0 | 0 | 0 | 0 | 0 |
| **25-50** | **Medium** | 18 (45) | 40.0 | 8 (66.67) | 37.0 | 8 (57.14) | 36.0 |
| **50-75** | **High** | 10 (25) | 60.0 | 4 (33.33) | 67.0 | 6 (42.86) | 61.7 |
| **75-100** | **Very high** | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 6: Strategies of Sustainable Crop Production in Rainfed Region**

| S. No | Coping Strategies | No of Farmers Adopted | Constraints |
|---|---|---|---|
| **Water management** | | | |
| 1 | Farm ponds | 0 | • Lack of finance<br>• Labour shortage<br>• Higher cost<br>• Lack of knowledge<br>• Inadequate rainfall |
| 2 | Summer ploughing | 50 | |
| 3 | Vegetative barriers | 0 | |
| 4 | Ridges and furrows | 0 | |
| | **Nutrient management** | | |
| 1 | Mulching | 2 | • Lack of resources<br>• Costly<br>• Lack of finance<br>• Lack of knowledge |
| 2 | Crop rotation with legumes | 14 | |
| 3 | Addition of Farmyard manure | 30 | |
| 4 | Seed treatment with biofertilizers | 14 | |
| 5 | Integrated Nutrient management | 8 | |
| 6 | Foliar spray | 12 | |
| **Crop and cattle insurance** | | 4 | • No trust as the rejection of claiming proposal by insurance companies<br>• No adequate compensation is given |
| **Mechanisation** | | 4 | • Costly |
| **Income Diversification** | | 50 | • Lack of skill<br>• Lack of employment opportunities |
| **Formal marketing** | | 4 | • Transport charges |
| **Contingency crop planning** | | 0 | • No knowledge |
| **Cropping systems** | | | |
| 1 | Intercropping | 24 | • Lack of finance<br>• Fear of loss<br>• Lack of technical knowledge<br>• Labour shortage<br>• Inadequate rainfall<br>• Lack of marketing facilities<br>• Risk averse |
| 2 | Agri-horti system | 0 | |
| 3 | Agroforestry system | 2 | |
| 4 | Fodder system | 8 | |
| 5 | Integrated Farming System | 42 | |

***REFERENCES***


1. *Central Institute for Dryland Agriculture-Perspective Plan Vision 2025.1997. http://www.crida.in/Vision%202025.pdf*
2. *International Water Management Institute-Water Issue Brief- Managing water for rainfed agriculture.2010.http://www.iwmi.cgiar.org/Publications/Water_Issue_Briefs/PDF/Water_Issue_Brief_10.pdf.*
3. *Praveen K.V, Suresh A, Reddy A.A and Singh D.R.2018. Risks and adaptation strategies in rainfed agriculture in India: An analysis. Indian Journal of Agricultural Sciences 88(6):958-63.*
4. *Pallavi, E., & Bhanu, M. (2016). Green HRM: A Way for Corporate Sustainability.*
5. *Raman M.S. 2017.Sustainability of rainfed Agriculture in Tamil Nadu-An Economic Analysis.Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore (India).pp 222.*
6. *Rao and Gopinath.2016.Resilient rainfed technologies for drought mitigation and sustainable food security. MAUSM 67(1) :169-182*
7. *Bouza-Herrera, C. N., Santiago, A., & Sautto, J. M. Ranked Set Sampling Strategies for the Eliminated Scrambling Variance Response Models.*
8. *Sahu P.K, Kundu A.L, Mani P.K and Pramanical M.2005.Sustainability of different nutrient combination in a long term rice-wheat cropping system. Journal of New Seed 7(3): 91- 10.*
9. *Olubunmi, O. A., Timothy, I. O., Alabi, A. O., & Israel, O. T. (2014). Competitive strategies of selected quantity surveying firms in Nigeria. International Journal of Management, Information Technology and Engineering, 2(11), 1-18.*
10. *Sharma K.D.2011.Rainfed agriculture could meet the challenges in India. Current Science. 100(11):1615-1616.*
11. *Singh R.P, Das S.K, Bhaskar Rao V.M and Narayana Reddy M.1990.Towards Sustainable Dryland Agricultural Practices. Technical Bulletin, Central Research Institute for Dryland Agriculture, Hyderabad, India. p 106.*
12. *Suseela K, and Chandrasekeran M.2018.Technology Adoption in Dryland Crops of Andhra Pradesh. International Journal of Agricultural Sciences 10(10):6081-60*


## AUTHOR PROFILE

**Dr. A. Vidhyavathi** is currently working as Associate Professor of Agricultural Economics at Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore. She completed her PhD in Agricultural Economics. She has fifteen years of experience in teaching, research and extension. She has specialised in the field of natural resource economics especially in water and forest resource management. She was awarded with the Best Doctoral Research for forest accounting. She has involved in under graduate and post graduate teaching. As Co-Principal Investigator,she has handled externally funded research schemes sponsored by Central Planning Commission Government of India, Tribal Cooperative Marketing Development Federation of India (TRIFED), Tamil Nadu News Prints and Papers Limited (TNPL), Indian Council of Forestry Research and Education (ICFRE), Bank of India, Waseda University, Japan, National

Agricultural Development Project(NADP) and International Maize and Wheat Improvement Centre (CIMMYT), Mexico. She has guided five post graduate students and seven under graduate students. She has co-authored four books and contributed five book chapters. She has published many research articles in reputed national and international journals.